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Award Number: MIPR 1DCB8D1065

TITLE: LRMC Remote Nerve Fiber Laser Analysis and Teleophthalmology Project

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REPORT DATE: December 2002

TYPE OF REPORT: Final

PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

# REPORT DOCUMENTATION PAGE

*Form Approved*
*OMB No. 074-0188*



| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | December 2002 | Final (31 Dec 00-31 Dec 02) |

**4. TITLE AND SUBTITLE**
LRMC Remote Nerve Fiber Laser Analysis and Teleophthalmology Project

**5. FUNDING NUMBERS**
MIPR 1DCB8D1065

**6. AUTHOR(S)**
Todd David Hess
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**8. PERFORMING ORGANIZATION REPORT NUMBER**

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**
U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

**12a. DISTRIBUTION / AVAILABILITY STATEMENT**
Approved for Public Release; Distribution Unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT (Maximum 200 Words)**

See attached.

**14. SUBJECT TERMS**
No subject terms provided.

**15. NUMBER OF PAGES**
15

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
|---|---|---|---|
| Unclassified | Unclassified | Unclassified | Unlimited |

# TABLE OF CONTENTS

Cover

SF 298

Table of Contents

Abstract

Body

Key Research Accomplishments

Reportable Outcomes

Conclusions

Appendix A: Technical Summary

Appendix B: Funded Personnel and Participants

Appendix C: Supporting Documentation

Appendix D: Presentations, Posters, Publications

# ABSTRACT

## NERVE FIBER LAYER ANALYSIS TELECONSULTATION

Major Christopher S. Allen, Lieutenant Colonel Todd D. Hess, Major Jim H. Burden, Lieutenant Colonel Richard H. Birdsong, Department of Ophthalmology, Landstuhl Regional Medical Center, Germany

Objective: To test the efficacy and efficiency of transmitting digital nerve fiber layer analysis (Gdx) results via e-mail for teleconsultation.

Methods: Retrospective study using 30 random Gdx images from 30 eyes. The images were printed on regular 8.5 X 11 inch paper from the Gdx printer. Patient identifiers were removed and the paper image was scanned using a Hewlett Packard ScanJet ADF and saved as JPEG files on a personal computer. The 30 scanned image files were emailed to three military glaucoma consultants via the World Wide Web using Outlook. The 30 printed, paper images were mailed via United States Postal Service to each of the three consultants along with a questionnaire asking the glaucoma consultants to evaluate the quality of the emailed Gdx images compared to the original paper Gdx printouts.

Results: The Gdx images were easily printed out from the Gdx machine and scanned. It took less than 20 seconds to save a Gdx image as a JPEG file. It took less than 10 seconds to send the email message with the scanned Gdx attachments. Two of the three glaucoma specialists felt quality of emailed images where sufficient and would feel comfortable using them in place of the original image. .

Conclusion: Electronic transmission of Gdx images via email was easy and efficient. Two of the three glaucoma consultants felt the emailed Gdx images were of sufficient quality to use instead of the original hard copy. This method of consultation could prevent unnecessary air evacuations to CONUS saving thousands of dollars and hundreds of man-hours, however due to our patient population this benefit was not realized.

## BODY

Nerve Fiber Layer Analysis Teleconsultation

- Funding: FY01 $75,400
- Funds used to purchase: Laser Diagnostic Technologies GDx Nerve Fiber Layer Analyzer
- MIPR # 1DCB8D1065

**Introduction**:
Telemedicine remains a very interesting area for military medicine, as with its implementation, specialist and subspecialist consultations at larger centers can be obtained for patients in remote areas without necessitating patient transport. The potential for savings and decreased mission down time are enormous. Very little is known, however, about the suitability of various types of images for transmission. This area is remains relatively uncharted in the medical literature.

GDx is an adjunctive instrument used in the diagnosis and management of glaucoma. It uses scanning laser light to measure nerve fiber layer thickness around optic nerve. Data is analyzed by the GDx computer and a print out on 8.5 in x 11 in paper generated. This information is useful in evaluating optic nerve for damage.

**Methods**:
This was a retrospective study using 30 random Gdx images from 30 eyes. The images were printed on regular 8.5 X 11 inch paper from the Gdx printer. Patient identifiers were removed and the paper image was scanned using a Hewlett Packard ScanJet ADF and saved as JPEG files on a personal computer. The 30 scanned image files were emailed to three military glaucoma consultants via the World Wide Web using Outlook. The 30 printed, paper images were mailed via United States Postal Service to each of the three consultants along with a questionnaire asking the glaucoma consultants to evaluate the quality of the emailed Gdx images compared to the original paper Gdx printouts.

**Results:**
The Gdx images were easily printed out from the Gdx machine and scanned. It took less than 20 seconds to save a Gdx image as a JPEG file. It took less than 10 seconds to send the email message with the scanned Gdx attachments. Two of the three glaucoma specialists felt quality of emailed images where sufficient and would feel comfortable using them in place of the original image. Listed below in table format are results for questions 1 thru 8 of the questionnaire. Raters BF, ED, and LF answered 8 questions for each of the 30 images. The mean score as well as range of scores are listed for each question by rater.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Rater | Ques 1 Mean (range) | Ques 2 Mean (range) | Ques 3 Mean (range) | Ques 4 Mean (range) | Ques 5 Mean (range) | Ques 6 Mean (range) | Ques 7 Mean (range) | Ques 8 Mean (range) |
| BF | 1 (1-1) | 6.1 (5-9) | 5.7 (3-6) | 8.9 (7-9) | 8.9 (7-9) | 7.8 (5-9) | 9.0 (8-10) | 8.9 (8,9) |
| ED | 2.7 (2-7) | 4.1 (2-6) | 2.7 (1-4) | 3.1 (2-4) | 3.1 (2-8) | 4.1 (2-7) | 3.1 (1-7) | 7.3 (2-9) |
| LF | 1 (1-1) | 8.6 (4- | 8.4 (4- | 9.2 (4- | 9.17 (4- | 9.3 (5- | 9.2 (5-10) | 10 (10- |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 10) | 10) | 10) | 10) | 10) | | 10) |
| | | | | | | | | |

•**Cost of care pillar**:
Potential for cost savings by preventing unnecessary airevacuations by giving CONUS glaucoma specialists pertinent visual data with which to render opinion.

•**Access to care pillar:**
Tremendous potential increase in access of patient data to subspecialty consultation only available at major medical centers

•**Quality of care pillar**:
Dramatic potential for increased quality by allowing rapid consultation with sub specialists not available in theatre

•**Problems encountered**:
1. Due to the relatively healthy young population with relatively uncomplicated glaucoma our clinic does not generate a sufficient number of abnormal Gdx Studies to supply an adequate N for statistical study. We could not evaluate actual cost savings since no glaucoma patients were severe enough to require air evacuation for higher level care.

2. We did not take delivery of GDx device until March 2001 delaying start of study.

3. There was a significant delay in starting the study due to IRB/human use approval process which resulted in the decision to use pre-existing data to meet reporting timelines.

3. The OPSTEMPO of LRMC with OEF workload in addition to Warfighter Refractive Surgery Program start-up limited time for the telemedicine study

4. The neuro-ophthalmologist at LRMC interested in using GDx for teleconsultation PCS'd prior to study beginning limiting eligible patients

**AMEDD applicability**:
This study showed efficacy but limited usefulness in European theatre due to low incidence of glaucoma. This device could be very useful in a rural area with a large, elderly, retiree population with a higher incidence glaucoma without access to glaucoma specialist

**CONCLUSIONS:**
Electronic transmission of Gdx images via email was easy and efficient. This technology has potential to prevent unnecessary air evacuations to CONUS saving thousands of dollars and hundreds of man-hours. Due to the limitations described above this potential was unrecognized and will likely remain so. We would not recommend the Gdx for AMEDD wide adoption. We recommend leaving the decision up to individual clinics based on local need.

## KEY RESEARCH ACCOMPLISHMENTS

We determined that the Gdx images could be sent efficiently with good quality via the internet from Europe to CONUS.

Two of the three glaucoma specialists felt quality of emailed images where sufficient and would feel comfortable using them in place of the original image.

We determined that due to patient population statistics in our catchment area that the Gdx technology is not as useful as it might be in other situations.

## REPORTABLE OUTCOMES

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Electronic transmission of Gdx images via email was easy and efficient. This technology has potential to prevent unnecessary air evacuations to CONUS saving thousands of dollars and hundreds of man-hours. Due to the limitations described above this potential was unrecognized and will likely remain so. We would not recommend the Gdx for AMEDD wide adoption. We recommend leaving the decision up to individual clinics based on local need.

# APPENDIX A: TECHNICAL SUMMARY

Laser Diagnostic Technologies GDx Nerve Fiber Layer Analyzer was instrument used for the study.

Print outs of GDx analysis were scanned using a Hewlett Packard ScanJet ADF and saved as JPEG files on a personal computer.

JPEG files were emailed using outlook from ophthalmology clinic personal computer

## APPENDIX B: FUNDED PERSONNEL AND PARTICIPANTS

PI: Todd Hess
Assistant PI and executer of study: Christopher S. Allen

Glaucoma specialists:
Erin Doe
Lilia Fanin
William Flynn

## APPENDIX C: SUPPORTING DOCUMENTATION

### Gdx (nerve fiber layer analysis) Study Questionnaire
### Part One

After opening the attached Gdx image file from the Internet answer the questions below. Please note the Gdx ID # (found top center of printout) here _____.

1) How long did it take you to open the file (from the time you clicked on the attachment to the time the image appeared on your screen for review). Please pick a number between 1 and 7.

1) 1-5 seconds. --- 2) 6-15 seconds ---- 3) 16- 30 seconds --- 4) 31- 60 seconds.--- 5) 61 – 180 seconds-----6) greater than 181 seconds (3 minutes)----—7) could not open file.

After reviewing the electronically transmitted Gdx image please answer the questions below. (This is done prior to reviewing the original Gdx printout)

2) How would you rate the quality of the "scanning laser image of the disc" (top left image) of the transmitted Gdx printout on a scale of 1 to 10 (1 being poor quality and 10 being very good quality). Quality is defined as ability to distinguish the necessary clinical information from the picture to have it be useful in clinical practice.

1-----2-----3-----4-----5-----6-----7-----8-----9----10

3) How would you rate the quality of the "retinal nerve fiber layer analysis image" (top right image) of the transmitted Gdx printout on a scale of 1 to 10 (1 being poor quality and 10 being very good quality). Quality is defined as ability to distinguish the necessary clinical information from the picture to have it be useful in clinical practice.

1-----2-----3-----4-----5-----6-----7-----8-----9----10

4) How would you rate the overall quality of the electronically transmitted Gdx printout (the entire printout) on a scale of 1 to 10 (1 being poor quality and 10 being very good quality). Quality is defined as the ability to distinguish the necessary clinical information from the entire electronically transmitted Gdx printout to have it be useful in clinical practice.

1-----2-----3-----4-----5-----6-----7-----8-----9----10

## Gdx (nerve fiber layer analysis) Study Questionnaire

PART TWO

Now compare the electronically transmitted Gdx printout to the original Gdx printout and answer the questions below. Please ensure the number identifier of the original matched the number identifier of the e-mailed version.

5) How would you rate the quality of the "scanning laser image of the disc and peripapillary area" on the electronically transmitted Gdx printout compared to the original Gdx printout on a scale of 1 to 10 (1 being poor quality and 10 being very good quality). Quality is defined as ability to distinguish the necessary clinical information from the picture to have it be useful in clinical practice.

1-----2-----3-----4-----5-----6-----7-----8-----9----10

6) How would you rate the overall quality of the electronically transmitted Gdx printout compared to the original on a scale of 1 to 10 (1 being poor quality and 10 being very good quality). Quality is defined as ability to distinguish the necessary clinical information from the picture to have it be useful in clinical practice.

1-----2-----3-----4-----5-----6-----7-----8-----9----10

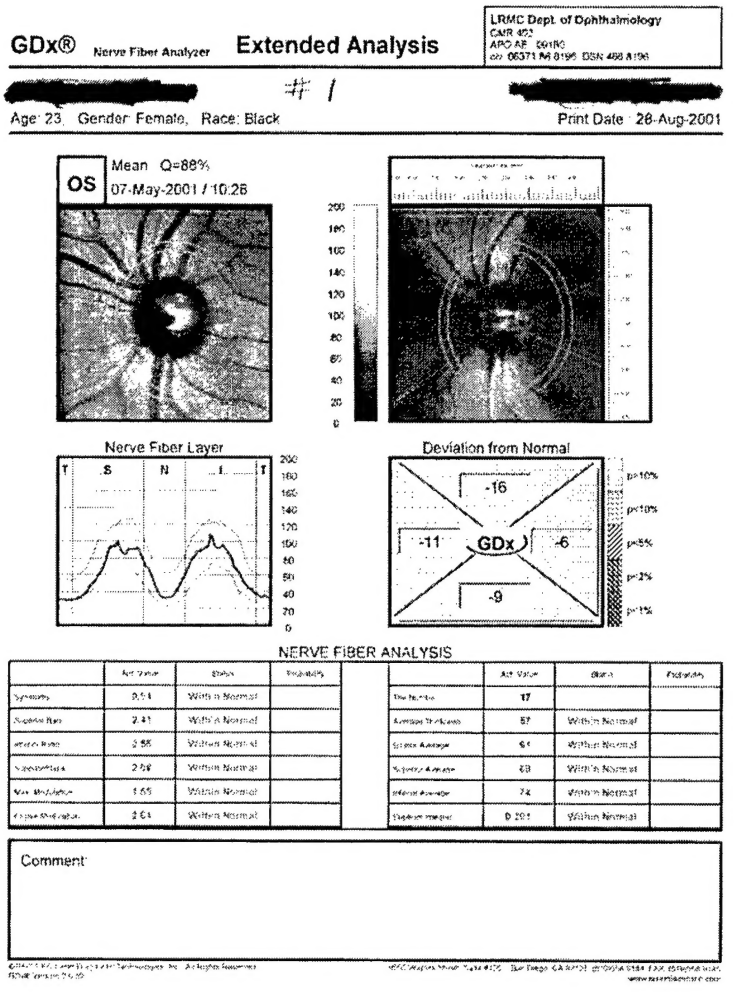
7) How would you rate your confidence in being able to use the electronically transmitted Gdx printout instead of the original Gdx printout in clinical practice on a scale of 1 to 10 (1 being not confident at all and 10 being very confident).

1-----2-----3-----4-----5-----6-----7-----8-----9----10

8) How would you rate the overall efficiency (ease of use) of receiving and opening the Gdx e-mail attachments on a scale of 1 to 10 (1 being very cumbersome and difficult to use and 10 being easy to use).

1-----2-----3-----4-----5-----6-----7-----8-----9----10

# Example of Gdx image



## APPENDIX D: PRESENTATIONS, POSTERS, PUBLICATIONS

Power point presentation for final report in California as well as for Air Force Clinical Surgeon's Meeting in Las Vegas. The powerpoint presentation is available via email with graphics. Mr. Winston has copy of presentation.